Missouri Department of Natural Resources

BIOLOGICAL ASSESSMENT AND HABITAT STUDY

(Lower) Mussel Fork
Adair & Macon Counties

2004 - 2005

Prepared for:

Missouri Department of Natural Resources
Division of Environmental Quality
Water Protection Program
Water Pollution Control Branch

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1.0 Introduction

At the request of the Missouri Department of Natural Resources (**MDNR**), Water Protection Program (**WPP**), the Environmental Services Program (**ESP**), Water Quality Monitoring Section (**WQMS**) conducted a macroinvertebrate bioassessment and habitat study of Mussel Fork in southern Adair and Macon Counties in north central Missouri. This study was completed in accordance with Sediment TMDL Strategy agreed upon by the WQMS and WPP (Appendix A).

Approximately 29 miles of Mussel Fork in Sullivan, Adair, and Macon Counties are included on the 2002 303(d) list for sediment pollution from agricultural nonpoint sources. Although habitat loss is not an impact found on the 303(d) list, there are segments of Mussel Fork that have poor habitat due to channelization, vertical banks, and poor riparian zones. A previous department study (MDNR 2003a) assessed the upper 15 miles of Mussel Fork from the confluence of Little Mussel Fork in Adair County, to Section 2, Township 62 North, Range 18 West in Sullivan County. This study assesses the lower 14 miles of Mussel Fork from Section 31, Township 61 North, Range 17 West in Adair County (at the confluence of Little Mussel Creek) to Section 18, Township 58 North, Range 17 West in Macon County. The 14 miles of lower Mussel Fork addressed in this study are listed as Class C waters, water body I.D. #0674 (MDNR 2000), and constitute approximately the lower ½ of the listed segment.

1.1 Purpose

The purpose of the study was to determine if the lower Mussel Fork macroinvertebrate community is impaired and, if so, determine potential causes.

1.2 Objectives

1) Define the habitat characteristics of lower Mussel Fork.
2) Define the water quality characteristics of lower Mussel Fork.
3) Determine if the macroinvertebrate community and water qualities of lower Mussel Fork are affected by factors related to habitat loss.

1.3 Tasks

1) Conduct a habitat assessment of lower Mussel Fork.
2) Conduct a water quality assessment of lower Mussel Fork.
3) Conduct a bioassessment of the macroinvertebrate community of lower Mussel Fork.

1.4 Null Hypotheses

1) Habitat will not substantially differ between lower Mussel Fork and biocriteria reference streams within the Plains/Grand/Chariton Ecological Drainage Unit or among lower Mussel Fork stream segments.
2) Water quality will not substantially differ between lower Mussel Fork and biocriteria reference streams within the Plains/Grand/Chariton Ecological Drainage Unit or among lower Mussel Fork stream segments.
3) Macroinvertebrate assemblages will not substantially differ between lower Mussel Fork and biocriteria reference streams within the Plains/Grand/Chariton Ecological Drainage Unit or among lower Mussel Fork stream segments.

2.0 Study Area

The headwaters of Mussel Fork lie in an area between the cities of Green City and Green Castle in northeastern Sullivan County. It flows south for approximately 60-70 miles through Adair, Macon, Linn, and Chariton Counties to its confluence with the Chariton River approximately 2 miles south of Keytesville and approximately 6 miles north of the confluence of the Chariton River with the Missouri River. The entire drainage of the creek is approximately 350 square miles. The drainage basin is linear in shape stretching almost 60 miles north to south and being approximately 8 miles wide at its widest point.

Northern Missouri landforms are the result of glaciation and consist of plains and low rolling hills. Agriculture is a major industry in northern Missouri including row crops and confined animal feeding operations. In many cases row crops are planted up to the banks of streams, thereby decreasing the quality of the riparian zone and leading to unstable banks and a loss of woody debris input to the stream, which in turn results in a loss of habitat. Many of the larger streams and rivers in northern Missouri have been channelized to provide more area in the river bottoms for cropland. Channelization causes a loss of channel structure, which would normally promote the formation of good quality habitats.

2.1 Station Descriptions

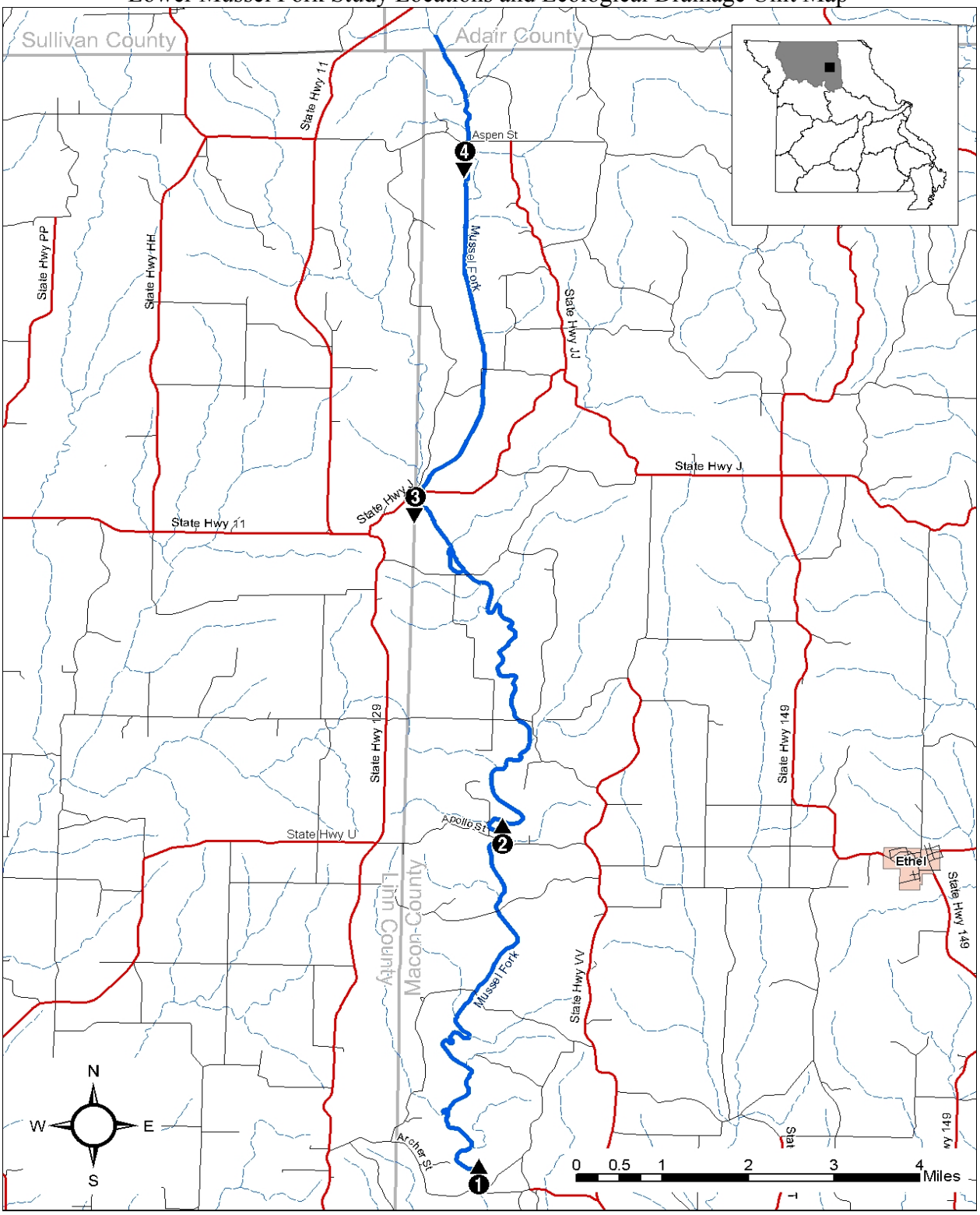
Four stations were chosen systematically along lower Mussel Fork. Each station represents stream conditions locally and for an area approximately 4-5 miles upstream. See Figure 1 for a map of study locations.

Mussel Fork Station 1: (NE ¼ SE ¼ sec. 18, T. 58 N., R. 17 W.) Station 1 is located at the lower limit (southern end) of the study reach, upstream of the Archer Street crossing in western Macon County. The channel appears to be unaltered and the stream has a healthy riparian zone. Stream discharge was measured at 3.26 cfs in fall 2004 and 11.9 cfs in spring 2005. Geographic coordinates for this study station are Latitude 39° 50’ 12.8”, Longitude -92° 50’ 9.4”.

Mussel Fork Station 2: (NE ¼ sec. 29, T. 59 N., R. 17 W.) Station 2 is located approximately 6.0 miles upstream of Station 1, upstream of the Apollo Street crossing in western Macon County. Much like Mussel Fork Station 1, the channel appears to be unaltered, but the quality of the riparian zone is relatively poor, being quite poor on one side. Stream discharge was measured at 2.12 cfs in fall 2004 and 12.8 cfs in spring 2005. Geographic coordinates for this study station are Latitude 39° 53’ 49.7”, Longitude -92° 49’ 50.4”.

Mussel Fork Station 3: (NW ¼ sec. 6, T. 59 N., R. 17 W.) Station 3 is located approximately 6.5 miles upstream from Station 2, downstream of Missouri Highway J in western Macon County. The channel appears to be somewhat altered and the quality of the riparian zone is mixed, relatively pristine on one side but lacking entirely on the other. Stream discharge was measured at 1.53 cfs in fall 2004 and 11.9 cfs in spring 2005. Geographic coordinates for this study station are Latitude 39° 57’ 30.6”, Longitude -92° 50’ 58.3”.

Figure 1
Lower Mussel Fork Study Locations and Ecological Drainage Unit Map



Mussel Fork Station 4: (N ½ sec. 18, T. 60 N., R. 17 W.) Station 4 is located approximately 4.6 miles above Station 3, downstream of Aspen Street in northwestern Macon County. The channel appears to be somewhat altered and the quality of the riparian zone is mixed, quite good on one side but poor on the other. Stream discharge was measured at 1.03 cfs in fall 2004 and 11.1 cfs in spring 2005. Geographic coordinates for this study station are Latitude 40° 1' 10.1", Longitude -92° 50' 18.4".

2.2 Control Station Description

West Locust Creek: (NE ¼ sec. 11, T. 61 N., R. 21 W.) The West Locust Creek site was located upstream of Timber Road in Sullivan County southwest of Milan, Missouri. This station was just downstream from a Biocriteria Reference stream segment within the EDU. It is targeted to be part of an expanded reference section of West Locust Creek in the future. Data collected from this station was used as a control comparison to lower Mussel Fork. Stream discharge was measured at 1.1 cfs in fall 2004 and 13.1 cfs in spring 2005. Geographic coordinates for this station are Latitude 40° 06' 8.5", Longitude -93° 13' 1.7".

3.0 Methods

Mike Irwin, Randy Sarver, Steve Humphrey, Cecelia Campbell, and other staff of the Missouri Department of Natural Resources, Division of Environmental Quality, Environmental Services Program conducted this study. Samples were collected at sites that had a gradient of habitat characteristics. Sampling was conducted during the fall of 2004 and the spring of 2005. Fall sampling was conducted on September 28 and 29, 2004 and consisted of macroinvertebrate sampling, water quality sampling, habitat assessments, and stream morphology measurements at four stations on upper Mussel Fork. Spring sampling was conducted on March 22, 23, and 24, 2005 and consisted of macroinvertebrate and water quality sampling.

3.1 Habitat

Mussel Fork was placed on the 303(d) list for stream habitat degradation through excessive sedimentation. No suspended sediment data exists to directly document sediment as a significant impact to the stream. General fisheries data and the effect of sediment upon fish were the initial data to consider Mussel Fork for 303(d) listing. Sedimentation is one of many instream habitat problems associated with land use. Although instream habitat can be directly measured, the causes of the degradation can range from local scale sources to watershed scale sources. We collected habitat measures at the watershed scale, the reach scale, and the habitat scale to better allow us to evaluate the causes of poor habitat conditions.

3.1.1 Land Use

The land use conditions were summarized from land cover GIS files. These land cover files were provided by the Missouri Resource Assessment Partnership (**MoRAP**) and derived from 1991-1993 LANDSAT data.

In addition, Mussel Fork was included in a study in which the MDNR provided funding to the University of Missouri for evaluation of reference streams in Northern Missouri (Haithcoat et al.,

2003). As part of the final report to the department, a five-parameter land cover model was developed to facilitate the definition of reference streams.

3.1.2 Habitat

A standardized assessment procedure was followed as described for Glide/Pool Habitat in the Stream Habitat Assessment Project Procedure (**SHAPP**) (MDNR 2003b). The habitat assessment was conducted on Mussel Fork during the fall 2004 sample season.

3.1.3 Sinuosity

Sinuosity was used as a surrogate measure of the amount of channelization that has taken place. Sinuosity was measured using GIS and a Valley Segment Type stream coverage provided by MoRAP. For this report, sinuosity is represented as a ratio of the actual length between two points on the stream to the straight-line distance between the points. Two different methods were used to determine sinuosity. For one method, measurement points were approximately two miles apart with the sampling reach at the center, and the ratio was generated for the entire two-mile reach. For the other method, measurement points were approximately two miles apart with the sampling reach at the center, but an average ratio was generated from the ratios of two one-mile segments within the two-mile reach.

3.1.4 Stream Morphology

Lack of instream habitat can be visually observed in Northern Missouri streams that are wide and shallow. Wider, shallower streams tend to have less ability to develop pools and retain woody debris (Haithcoat et al., 2003). At each sampling station a series of 10 bank to bank transects were established. Each transect was equally spaced within the sampling reach, which is 20x the average channel width. Measurements taken at each transect included lower bank width (see the Stream Habitat Assessment Procedure for a definition of Lower Bank), wetted width, and water depth at ¼, ½, and ¾ of the distance across the wetted width. In order to document critical habitat conditions, measurements were collected during the fall low flow period.

3.2 Physicochemical Water Parameters

Physical and chemical water samples were collected from all stations during both fall and spring. Parameters collected were nitrate+nitrite-nitrogen, ammonia-nitrogen, Total Kjeldahl Nitrogen, total phosphorus, chloride, turbidity, temperature, conductivity, dissolved oxygen, pH, and discharge. WQMS personnel analyzed temperature, conductivity, dissolved oxygen, pH, and discharge in the field and turbidity in the biology laboratory. All other parameters were delivered to the ESP Chemical Analysis Section for analyses. All samples were collected according to the standard operating procedure MDNR-FSS-001: Required/Recommended Containers, Volumes, Preservatives, Holding Times, and Special Sampling Considerations (MDNR 2003c) and were recorded on an MDNR chain-of-custody (MDNR 2005a).

3.3 Biological Assessment

The biological assessment was conducted according to the Semi-quantitative Macroinvertebrate Stream Bioassessment Project Procedure (**SMSBPP**) (MDNR 2003d). All stations were sampled in September 2004 and March 2005. Three standard habitats of glide/pool streams (e.g. woody

debris substrate, depositional substrate in non-flowing water, and rootmat substrate) were sampled at all locations.

Macroinvertebrate data were evaluated by comparison to Biological Criteria for Perennial/Wadeable (**BIOREF**) streams of the Plains/Grand/Chariton Ecological Drainage Unit (**EDU**). An EDU is an ecological area in which the aquatic biological communities and stream habitat can be expected to be similar. See Figure 1 for a map of the EDU's of Missouri.

Biological criteria are calculated separately for the fall (mid-September through mid-October) and spring (mid-March through mid-April) index periods. The SMSBPP provides details on the calculation of metrics and scoring of the multi-metric Macroinvertebrate Stream Condition Index (**MSCI**). The four core metrics of the MSCI are: Taxa Richness (**TR**); Ephemeroptera, Plecoptera, and Trichoptera Taxa (**EPTT**); Biotic Index (**BI**); and the Shannon Diversity Index (**SDI**). An MSCI score of 16-20 is considered full biological sustainability, 10-14 is partial biological sustainability, and 4-8 is non-biological sustainability. Table 1 provides scoring criteria for the fall index period and Table 2 for the spring index period.

Table 1
Biological Criteria for Glide/Pool-Fall Index Period
Plains/Grand/Chariton EDU

Metric	Score = 1	Score = 3	Score = 5
TR	< 26	26 – 51	> 51
EPTT	< 4	4 – 9	> 9
BI	> 8.60	8.60 – 7.20	< 7.20
SDI	< 1.34	1.34 – 2.68	> 2.68

Table 2
Biological Criteria for Glide/Pool-Spring Index Period
Plains/Grand/Chariton EDU

Metric	Score = 1	Score = 3	Score = 5
TR	< 26	26 – 51	> 51
EPTT	< 4	4 – 8	> 8
BI	> 8.62	8.62 – 7.24	< 7.24
SDI	< 1.26	1.26 – 2.53	> 2.53

4.0 Results and Analyses

4.1 Habitat

As noted in the methods section, habitat measures were collected at the watershed scale, the reach scale, and the habitat scale for better evaluation of the causes of poor habitat conditions.

4.1.1 Land Use

According to MoRAP land cover files, the lower reach of the Mussel Fork drainage basin, which is the subject of this report, is comprised of mainly cool season grassland (~46%), deciduous forest (~40%), and row crops (~7%). When compared to surrounding watersheds, this watershed contains more deciduous forest and cool season grassland in place of row crops.

Table 3 provides two scales of land use comparison. A broad scale comparison is provided by comparing the 14-digit hydrologic units (**HU**) for lower Mussel Fork stations with the Plains/Grand/Chariton EDU. A watershed comparison is also provided by comparing the 14-digit HU for lower Mussel Fork stations with the 14-digit HU of three nearby BIOREF streams in the EDU.

Compared to the Plains/Grand/Chariton EDU, lower Mussel Fork has about the same amount of cool season grassland, much less row crops, and much more deciduous forest. In comparison to the three selected BIOREF streams, lower Mussel Fork has the least amount of land use dedicated to row crops. Lower Mussel Fork has less cool season grassland than the Locust Creek BIOREF and West Locust Creek BIOREF but more cool season grassland than the Spring Creek BIOREF. In contrast, lower Mussel Fork has more deciduous forest than the Locust Creek BIOREF and West Locust Creek BIOREF but less deciduous forest than the Spring Creek BIOREF.

Additional land cover information is available as part of a reference watershed model developed by Haithcoat et al. (2003). Mussel Fork is not considered a reference stream, but was included as a potentially impacted stream. Mussel Fork was the highest ranked test stream, and in fact land cover parameters did as well as many reference streams. Mussel Fork was not included as a potentially impacted test stream because of general watershed problems, but solely because of past water quality problems resulting from hog manure spills from a large confined animal feeding operation in it's headwaters.

Table 3
Land Use

Watershed	% Urban	% Row Crops	% Grassland	% Forest
Lower Mussel Fork	1	7	46	40
Plains/Grand/Chariton EDU	2	28	45	18
BIOREF Locust Creek	2	10	62	20
BIOREF Spring Creek-Adair Co.	1	10	28	55
BIOREF West Locust Creek	1	10	67	15

4.1.2 Habitat Assessment

In order to determine the acceptability of habitat, the lower Mussel Fork habitat scores were compared to the habitat score from the West Locust Creek control station. According to the SHAPP, a study stream that scores 75 percent of reference stream conditions is considered to have habitat that fully supports a similar biological community.

Habitat assessment scores of all lower Mussel Fork stations were comparable to the West Locust Creek control station score (Table 4). The habitat score for Mussel Fork Station 1 was actually higher that the West Locust Creek station, exceeding the control habitat score by approximately 13 percent. Percent similarity ranged from 111 percent at Mussel Fork Station 1 to 75.5 percent at Mussel Fork Station 4.

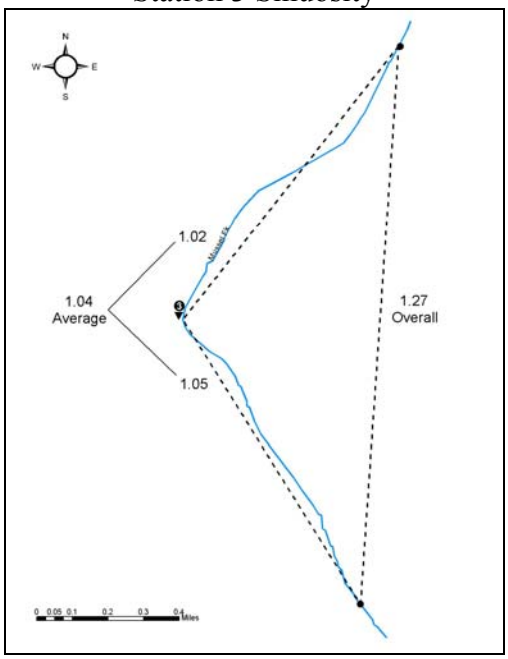
Table 4
Habitat Assessment Scores

Station	Habitat Assessment Score
Mussel Fork 1	111
Mussel Fork 2	88
Mussel Fork 3	75
Mussel Fork 4	74
Locust Creek control	98

4.1.3 Sinuosity

Table 5 (Station Reach Characteristics) lists sinuosity and channel characteristics for each sample station. Sinuosity ratios near 1 are considered potentially channelized. The sinuosity of lower Mussel Fork ranges from 1.04 to 1.64. Using the ratio for the entire reach versus using the average of the ratios from two one-mile segments yielded no difference except at Mussel Fork Station 3. While the ratio for the entire reach at Station 3 does not suggest the reach has been channelized, this may simply be a limitation of the method.

Figure 2
Station 3 Sinuosity



Each one-mile segment at Station 3 appears to be quite channelized and measuring these two segments independently and averaging the result of the two ratios may be more descriptive. Both one-mile segments approach the sampling reach from significantly different angles with the apex of the angle meeting at the Highway J bridge. Figure 2 (Station 3 Sinuosity) is a graphic representation of lower Mussel Fork Station 3 with emphasis on the two different methods of determining sinuosity. The derived line connecting the upstream and downstream points of the entire two-mile reach does not generally follow the stream. Therefore, the ratio generated using the entire two-mile reach (1.27) masks a possibly more representative degree of channelization when an average is taken for each of the two miles (1.04).

Table 5
Station Reach Characteristics

Station	*Sinuosity (miles/mile)	Likely to be Channelized
Mussel Fork 1	1.50	No
Mussel Fork 2	1.64	No
Mussel Fork 3	1.27 / 1.04**	Yes
Mussel Fork 4	1.04	Yes
West Locust Creek control	1.43	No

* Higher number equates to greater sinuosity.
**First number = entire 2 mi. reach, second number = average of two 1 mi. reaches (see Figure 2).

Based on sinuosity alone, the two downstream stations (1 & 2) are less likely to be channelized, while the two upstream stations (3 & 4) are more likely to be channelized. There is no evidence to suggest that any recent channelization has occurred on lower Mussel Fork; however, such low sinuosity values suggest historical channelization. In addition, the sinuosity values of the downstream stations are actually higher than the sinuosity value for the West Locust Creek control.

4.1.4 Stream Morphology

Station transect measurements for lower bank channel width, wetted width, and depth are provided in Appendix D.

A summary of stream width and depth measurements for lower Mussel Fork stations and the West Locust Creek control can be found in Table 6. While there are no clear progressions in channel measurement data, there are some general trends regarding channel width, wetted width, and depth. With a couple of exceptions, each of these measurements decreases in an upstream direction from the most downstream station on lower Mussel Fork.

Table 6
Stream Width and Depth Measurement Summary

Station	Average Channel Width (ft)	Average Wetted Width (ft)	Average Depth of Stream (ft)	Average Depth Standard Deviation	Channel Width / Wetted Width	Channel Width / Depth	Wetted Width / Depth
Mussel Fork 1	41.1	32.0	1.48	0.68	1.29	27.8	21.6
Mussel Fork 2	51.2	24.3	1.03	0.96	2.11	49.5	23.5
Mussel Fork 3	46.8	9.8	0.31	0.14	4.77	148.9	31.2
Mussel Fork 4	36.2	17.2	0.31	0.21	2.10	118.4	56.3
West Locust Creek control	40.8	23.3	1.41	1.18	1.75	28.9	16.5

Average channel width was highest at Station 2 at 51.2 feet and it was lowest at the most upstream station (4) at 36.2 feet. Average wetted width was highest at the most downstream station (1) and it was lowest at Station 3. Stream depth increased from upstream to downstream, averaging the lowest at 0.31 feet for both upstream stations (3 and 4) and averaging the highest at 1.48 feet for the most downstream station (1). In comparison to the West Locust Creek control

station, it appears that the most downstream station on lower Mussel Fork is most similar in channel width, wetted width, and depth, whereas upstream stations are progressively less similar.

In order to be able to compare stream stations in a longitudinal stream study it is sometimes necessary to incorporate ratios of measurements. Ratios can standardize measurements so that data such as channel width can be used in a manner that allows comparison of study stations regardless of their longitudinal placement. The ratios of channel width/wetted width, channel width/average depth, and wetted width/average depth are also given in Table 6. Higher channel width/wetted width values reflect a higher likelihood that streams have less potential for riparian shading, a deficiency that can be compounded when a stream meanders within its channel. Higher width/depth ratios represent a lack of habitat heterogeneity, showing tendency toward wide and shallow.

The channel width/wetted width ratio of Station 3 was the highest at 4.77, suggestive of poor riparian shading. The channel width/wetted width ratios of Stations 2 and 4 (2.11 and 2.10 respectively) are much better but not as low as the West Locust Creek control. The channel width/wetted width ratio of Station 1 was below that of the control.

Channel width/depth ratios were much higher for Stations 3 and 4. The channel width/depth ratio for Station 2 was much lower, but only Station 1 ranked better than the control. None of the lower Mussel Fork stations ranked better than the control regarding wetted width/depth ratios, but a clear progression toward wide and shallow is evident in a downstream to upstream direction. The wetted width/depth ratio of the most upstream station (4) was more than twice that of the two most downstream stations (1 and 2) and more than three times the control.

These ratios suggest a trend of reduced riparian shading and habitat heterogeneity in an upstream direction that may represent conditions with less potential for a diverse fish and macroinvertebrate community.

Average depth is another measure that relates to habitat quality. The average depths of Mussel Fork Stations 1 and 2 (1.48 and 1.03 feet respectively) were similar to the West Locust Creek Control (1.41 feet). The average depths of Stations 3 and 4 (both 0.31 feet) are quite shallow in comparison to the average depth of the West Locust Creek control. In addition, the standard deviation of the average depths from Stations 1 and 2 show that there is good depth variability, especially when compared to Stations 3 and 4.

When width/depth ratios and average depth metrics are compared, Stations 3 and 4 rank rather poorly compared to Stations 1 and 2.

4.2 Physicochemical Results

Results from the fall 2004 sampling season can be found in Table 7 and spring 2005 in Table 8.

No violations of Missouri water quality standards occurred during the fall 2004 or spring 2005 sampling seasons at any sampling stations on lower Mussel Fork.

Table 7
Fall 2004 Physicochemical Results

	Mussel Fork 1	Mussel Fork 2	Mussel Fork 3	Mussel Fork 4	West Locust Creek control
Sample #	434866	434867	434868	434869	434870
Ammonia as N (mg/L)	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03
Chloride (mg/L)	7.8	8.86	9.76	10.6	11.4
Dissolved Oxygen (mg/L)	7.8	8.3	8.2	7.3	5.8
Discharge (cubic ft/sec)	3.26	2.12	1.53	1.03	1.1
Nitrate + Nitrite as N (mg/L)	< 0.01	< 0.01	0.02	< 0.01	0.01
pH (su)	8.1	7.7	8	NA	7.7
Specific Conductivity (umhos/cm)	470	464	466	448	439
Temperature (°C)	18.7	22	12.5	17.3	15.4
Total Kjeldahl Nitrogen (mg/L)	0.57	0.51	0.39	0.42	0.6
Total Phosphorus (mg/L)	0.05	0.06	0.04	0.06	0.07
Turbidity (NTU)	8.34	6.91	3.33	15.3	8.81

Table 8
Spring 2005 Physicochemical Results

	Mussel Fork 1	Mussel Fork 2	Mussel Fork 3	Mussel Fork 4	West Locust Creek control
Sample #	502960	502961	502962	502963	503171
Ammonia as N (mg/L)	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03
Chloride (mg/L)	10.2	9.88	10.6	11.3	13.5
Dissolved Oxygen (mg/L)	13.2	11.9	13.1	13.8	9.3
Discharge (cubic ft/sec)	11.9	12.8	11.9	11.1	13.1
Nitrate + Nitrite as N (mg/L)	< 0.01	< 0.01	0.01	< 0.01	< 0.01
pH (su)	7.7	8.3	8.3	8.6	7.6
Specific Conductivity (umhos/cm)	390	483	469	467	470
Temperature (°C)	6.7	6.9	5.7	5.9	16.8
Total Kjeldahl Nitrogen (mg/L)	0.51	0.2	0.22	0.28	0.51
Total Phosphorus (mg/L)	0.08	0.03	0.03	0.05	0.04
Turbidity (NTU)	13.6	6.97	7.13	8.65	9.25

In comparison to the West Locust Creek control site, lower Mussel Fork sampling sites faired well in fall 2004 and spring 2005. Across a variety of parameters, there was generally little difference among the sampling sites and the control. It is notable that the West Locust Creek control site had the highest chloride and total kjeldahl nitrogen values for both seasons. In addition, dissolved oxygen values for the West Locust Creek control were the lowest for both seasons as well. The West Locust Creek Control had the lowest specific conductivity in fall 2004. However, none of these differences are noteworthy. There appears to be little, if any, physicochemical differences between lower Mussel Fork and the West Locust Creek control or among the lower Mussel Fork stations.

4.3 Biological Assessment

4.3.1 Macroinvertebrate Stream Condition Index Scores

The lower Mussel Fork metric results and MSCI scores for fall 2004 and spring 2005 are found in Table 9 and Table 10 respectively. MSCI scores are calculated by scoring station metrics against the appropriate criteria in Table 1 or Table 2.

Table 9
Fall 2004 Macroinvertebrate Stream Condition Index Scores

	Mussel Fork 1	Mussel Fork 2	Mussel Fork 3	Mussel Fork 4	West Locust Creek control
Sample Number	0418760	0418763	0418764	0418765	0418761
Taxa Richness	81	74	69	55	62
EPT Taxa	22	19	15	13	14
Biotic Index	6.39	6.13	5.61	6.53	6.73
Shannon Index	3.12	3.08	2.77	2.83	2.91
MSCI Score	20	20	20	20	20
Sustainability	Full	Full	Full	Full	Full

Table 10
Spring 2005 Macroinvertebrate Stream Condition Index Scores

	Mussel Fork 1	Mussel Fork 2	Mussel Fork 3	Mussel Fork 4	West Locust Creek control
Sample Number	0503045	0503046	0503047	0503048	0503065
Taxa Richness	65	56	62	57	60
EPT Taxa	13	10	12	9	10
Biotic Index	5.79	6.04	6.65	6.8	6.72
Shannon Index	2.64	2.77	3.07	3.00	2.73
MSCI Score	20	20	20	20	20
Sustainability	Full	Full	Full	Full	Full

4.3.2 Longitudinal Analyses

For the lower Mussel Fork segment covered by this study, the biological assessment suggests no biological impairment. Exactly 100% of the MSCI scores are $\geq$ 16 (full biological sustainability). During the development of biological criteria (MDNR 2002a), it was demonstrated that wadeable perennial reference streams stations scored $\geq$ 16 about 86% of the time.

Even though no biological impairment is suggested, there are possible trends among lower Mussel Fork samples that are worth noting. In fall 2004 samples, there is a notable decrease in TR and EPTT from downstream to upstream stations. While less obvious, this trend continues in spring 2005 samples. In addition, SDI numbers decline from downstream to upstream in fall 2004 samples, but the trend is reversed in spring 2005 samples. While none of these values differ significantly from the West Locust Creek control, it does suggest that there may be some discernable biological differences among lower Mussel Fork stations that are not detected using the MSCI.

As an additional analysis tool, the Quantitative Similarity Index for Taxa (**QSI-T**) can be used to compare the biota of stations. The QSI-T compares two aquatic communities in terms of presence or absence of taxa, also taking relative abundance of each taxa into account. Values less than 65% generally indicate environmental stress and values greater than 65% are representative of natural variation (Shackleford 1988). Matrices containing QSI-T scores can be found for fall 2004 and spring 2005 in Table 11 and Table 12 respectively.

Table 11
Fall 2004 Quantitative Similarity Index for Taxa

Station	Lower Mussel Fork 1	Lower Mussel Fork 2	Lower Mussel Fork 3	Lower Mussel Fork 4	West Locust Creek CONTROL
Lower Mussel Fork 1	100				
Lower Mussel Fork 2	70.1	100			
Lower Mussel Fork 3	65.1	**54.4**	100		
Lower Mussel Fork 4	67.6	74.1	**59.1**	100	
West Locust Creek CONTROL	68	71.5	**57.7**	75.3	100

Table 12
Spring 2005 Quantitative Similarity Index for Taxa

Station	Lower Mussel Fork 1	Lower Mussel Fork 2	Lower Mussel Fork 3	Lower Mussel Fork 4	West Locust Creek CONTROL
Lower Mussel Fork 1	100				
Lower Mussel Fork 2	71.4	100			
Lower Mussel Fork 3	**49.1**	**61**	100		
Lower Mussel Fork 4	**46.2**	**50.4**	69.4	100	
West Locust Creek CONTROL	**53.8**	**47.2**	**59.7**	**59.5**	100

For fall 2004 samples, one notable QSI-T difference exists when comparing Mussel Fork Station 2 with Mussel Fork Station 3. Other notable QSI-T differences for fall 2004 exist when Mussel Fork Station 3 is compared with Mussel Fork Station 4 and the West Locust Creek control. The QSI-T difference between Mussel Fork Station 1 and 3 is only slightly greater than 65%. In summary, for fall 2004 samples, noteworthy QSI-T differences exist between lower Mussel Fork Station 3 and nearly all other stations including the West Locust Creek control.

For spring 2005 samples, notable QSI-T differences occur when comparing Mussel Fork Station 1 with Mussel Fork Stations 3 and 4. Likewise, when comparing Mussel Fork Station 2 with Mussel Fork Stations 3 and 4, a similar QSI-T difference occurs. In addition, notable QSI-T differences exist between the West Locust Creek control and all Mussel Fork Stations. In summary, for spring 2005 samples, the only comparisons without noteworthy QSI-T differences are the comparison between Mussel Fork Stations 1 and 2 and between Mussel Fork Stations 3 and 4. All other comparisons yield noteworthy differences.

4.3.3 Ecoregional Analyses

As a temporal control, West Locust Creek, Sullivan County was re-sampled during fall 2004 and spring 2005. Study streams are evaluated during time periods that potentially include drought or high-flow periods. Therefore, a low reference stream score could indicate a response to naturally low or high water levels as well as anthropogenic impacts. West Locust Creek MSCI scores (Tables 9 & 10) scored the maximum potential points (20) and did not indicate weather induced problems.

5.0 Discussion

5.1 Habitat

When compared on a broad scale to the Plains/Grand/Chariton EDU, the Mussel Fork watershed exhibited less row cropping and more grasslands and forest. A watershed scale land use comparison of lower Mussel Fork and nearby biocriteria reference streams in the same EDU showed the lower Mussel Fork watershed to be in relatively good condition.

The SHAPP suggests a gradient of habitat conditions, with a decrease in habitat quality in an upstream direction. While all Mussel Fork stations are not comparable to each other, they were all comparable to the West Locust Creek control. Mussel Fork Station 1 did exceptionally well, and Stations 1 and 2 were the most similar to the West Locust Creek control. Mussel Fork Stations 3 and 4 were similar to the West Locust Creek control, but their habitat similarity was toward the bottom of the acceptable condition. Gradients in SHAPP scores were most evident in pool variability and channel alteration categories.

Mussel Fork Stations 1 and 2 exhibited substantial sinuosity. Mussel Fork Stations 3 and 4 lacked sinuosity, suggesting historical channelization.

Stream morphology measurements suggest a lack of riparian shading at Mussel Fork Station 3. In addition, Mussel Fork Stations 3 and 4 showed a lack of heterogeneity, having lower average depths and wider, shallower characteristics than Stations 1 and 2.

5.2 Physicochemical Water Parameters

The physicochemical characteristics of lower Mussel Fork samples acquired during this study are unremarkable. Physicochemical parameter values were similar among lower Mussel Fork stations and the West Locust Creek control and no violations of Missouri Water Quality Standards were experienced or suggested.

5.3 Biological Assessment

The MSCI score generated by this biological assessment of lower Mussel Fork suggest no biological impairment. QSI-T analyses of all lower Mussel Fork stations and the selected control show some differences in macroinvertebrate communities. Whether these differences are due to differences in habitat, discharge/watershed size, or a combination of these variables along with natural variation is extremely difficult to determine with the limited data available. Additional study regarding habitat and flow characteristics in northern Missouri streams would help determine the reasons for these differences.

5.4 Macroinvertebrates and Habitat

Macroinvertebrates have been shown to have good relationships to amounts of depositional sediment (Zweig and Rabeni 2001) in rock bottom streams. However, northern Missouri streams are largely composed of materials considered to be sediment (silt and sand) by many researchers. As in many northern Missouri reference streams, the bottom substrate of lower Mussel Fork is predominately sand. The results of this study suggest that lower Mussel Fork macroinvertebrate communities are very similar to reference streams. Depositional sediment does not appear to be a significant problem in lower Mussel Fork.

Although invertebrates are responsive to changes in substrate they may not be responsive to certain habitat problems. The lack of top predator fish has been shown to have good relationship to channelized streams and the resulting lack of pools (Williamson and Todd 2005; Vokoun and Rabeni 2003; MDNR 2005b). Although there is no definitive information available to ESP, lower Mussel Fork shows some evidence of channelization and resultant shallow water depths.

6.0 Conclusions

Habitat did not differ substantially between lower Mussel Fork and biocriteria reference streams within the Plains/Grand/Chariton EDU or the West Locust Creek control. However, habitat differed longitudinally among lower Mussel Fork stations in regard to SHAPP scores, sinuosity, and stream morphology characteristics.

Physicochemical parameters did not differ substantially between lower Mussel Fork and the West Locust Creek control stream within the Plains/Grand/Chariton EDU or among lower Mussel Fork stations.

According to MSCI values for each station, macroinvertebrate assemblages did not substantially differ between lower Mussel Fork and biocriteria reference streams within the Plains/Grand/Chariton EDU or among lower Mussel Fork stream segments. While habitat and QSI-T analyses of lower Mussel Fork macroinvertebrate communities may suggest lower habitat quality at Stations 3 and 4, macroinvertebrate assemblages showed no significant effect.

7.0 Recommendations

1) Propose the lower 14 miles of the listed portion of Mussel Fork for de-listing from the 303(d) list.

2) Recognize the need for development and incorporation of satisfactory fish bioassessment protocols into the department's aquatic bioassessment program.

3) Conduct fish bioassessments of extensively channelized streams to further evaluate the relationship between protection of aquatic life designated use, habitat conditions, pool depths, and stream channel characteristics.

8.0 Literature Cited

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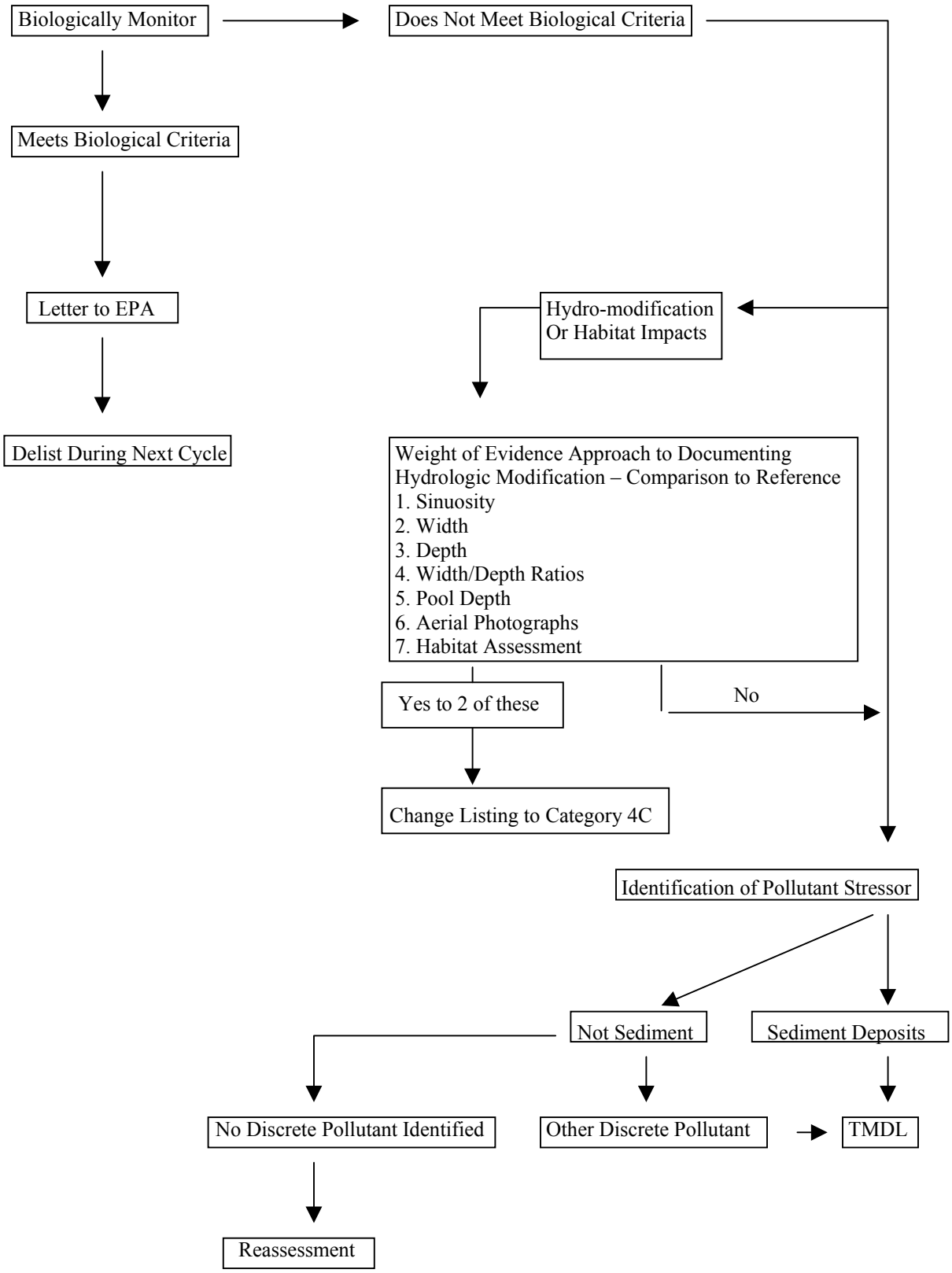
Appendix A
Sediment TMDL Strategy Document


Biologically Monitor
Does Not Meet Biological Criteria
Meets Biological Criteria
Letter to EPA
Delist During Next Cycle
Hydro-modification
Or Habitat Impacts
Weight of Evidence Approach to Documenting
Hydrologic Modification – Comparison to Reference
1. Sinuosity
2. Width
3. Depth
4. Width/Depth Ratios
5. Pool Depth
6. Aerial Photographs
7. Habitat Assessment
Yes to 2 of these
No
Change Listing to Category 4C
Identification of Pollutant Stressor
Not Sediment
Sediment Deposits
No Discrete Pollutant Identified
Other Discrete Pollutant
TMDL
Reassessment

APPENDIX B
Fall 2004
Macroinvertebrate Bench Sheets

Aquid Invertebrate Database Bench Sheet Report
Mussel Fk [0418760], Station #1
Sample Date: 9/28/2004 10:00:00 AM
NF = non-flow, RM = rootmat, SG = woody debris (snag)
-99 = present in sample

ORDER: TAXA	NF	RM	SG
"HYDRACARINA"			
Acarina	1	2	4
AMPHIPODA			
Hyalella azteca	3	26	1
COLEOPTERA			
Berosus		-99	
Dubiraphia	10	8	3
Helichus lithophilus		3	5
Hydroporus	2	11	3
Thermonectus		-99	
DECAPODA			
Orconectes virilis	-99		
DIPTERA			
Ablabesmyia	13	4	4
Anopheles	1		
Ceratopogoninae	4	1	4
Clinotanypus		1	
Corynoneura		1	
Cryptochironomus	2	1	
Dicrotendipes	2		5
Ephydridae			1
Erioptera			1
Forcipomyiinae			10
Glyptotendipes		5	4
Harnischia	1		
Hemerodromia			3
Labrundinia	2	7	10
Nanocladius		5	4
Nilotanypus			1
Ormosia	1		1
Parachironomus		1	2
Paracladopelma	1		
Parakiefferiella		2	3
Paralauterborniella		1	
Paratanytarsus		3	
Phaenopsectra	1	3	
Polypedilum			1
Polypedilum convictum grp		3	1

Aquid Invertebrate Database Bench Sheet Report
Mussel Fk [0418760], Station #1
Sample Date: 9/28/2004 10:00:00 AM
NF = non-flow, RM = rootmat, SG = woody debris (snag)
-99 = present in sample

ORDER: TAXA	NF	RM	SG
Polypedilum halterale grp	1		
Polypedilum illinoense grp	2	11	18
Procladius			1
Pseudochironomus			2
Rheocricotopus			1
Rheotanytarsus		42	
Stempellinella	10	1	1
Stenochironomus			7
Tanytarsus	72	55	43
Thienemanniella		1	4
Thienemannimyia grp.	2	16	26
Tribelos	2		8
EPHEMEROPTERA			
Acerpenna	4	17	45
Baetis		1	7
Baetiscidae	1		
Caenis latipennis	148	37	35
Callibaetis		4	
Heptageniidae			7
Hexagenia limbata	5		1
Leptophlebiidae	24	50	13
Procloeon	6	2	
Pseudocloeon		2	2
Stenacron	20	9	32
Stenonema femoratum	5		2
Stenonema terminatum			1
Tricorythodes		2	
HEMIPTERA			
Belostoma		-99	
LIMNOPHILA			
Physella		-99	-99
MEGALOPTERA			
Sialis	-99	-99	
ODONATA			
Argia	1	6	
Enallagma	4	10	1
Epicordulia		-99	
Gomphus	-99	-99	

Aquid Invertebrate Database Bench Sheet Report
Mussel Fk [0418760], Station #1
Sample Date: 9/28/2004 10:00:00 AM
NF = non-flow, RM = rootmat, SG = woody debris (snag)
-99 = present in sample

ORDER: TAXA	NF	RM	SG
Macromia	-99	-99	
Progomphus obscurus	-99	-99	
PLECOPTERA			
Neoperla		1	
RHYNCHOBDELLIDA			
Glossiphoniidae		-99	
TRICHOPTERA			
Cheumatopsyche	1	42	
Hydroptila		4	
Nectopsyche	1	3	
Nyctiophylax			1
Oecetis		1	
Polycentropodidae		7	
Triaenodes		1	
TRICLADIDA			
Planariidae	1		
TUBIFICIDA			
Enchytraeidae	2		
Tubificidae	4	1	1
VENEROIDEA			
Sphaeriidae	1	1	2

Aquid Invertebrate Database Bench Sheet Report
Mussel Fk [0418763], Station #2
Sample Date: 9/28/2004 2:45:00 PM
NF = non-flow, RM = rootmat, SG = woody debris (snag)
-99 = present in sample

ORDER: TAXA	NF	RM	SG
"HYDRACARINA"			
Acarina		4	1
AMPHIPODA			
Crangonyx		2	
Hyalella azteca		40	2
COLEOPTERA			
Dubiraphia	3	12	2
Helichus lithophilus		18	8
Hydroporus	5		1
Scirtes		1	2
DECAPODA			
Orconectes virilis	-99	-99	
DIPTERA			
Ablabesmyia	24	11	8
Anopheles		2	
Chironomus	6	1	
Cladotanytarsus	16	1	
Corynoneura			1
Cricotopus bicinctus	1	8	1
Cricotopus/Orthocladius			1
Cryptochironomus	10		
Dicrotendipes	16	2	7
Ephydridae		1	
Glyptotendipes		5	1
Hemerodromia		4	8
Labrundinia	3	24	11
Nanocladius	4	25	
Parachironomus		15	
Paracladopelma	1		
Parakiefferiella	1	1	4
Paralauterborniella	2		
Paratanytarsus	6	2	
Phaenopsectra		1	
Polypedilum	2	2	
Polypedilum convictum grp		6	5
Polypedilum fallax grp			2
Polypedilum halterale grp		1	2

Aquid Invertebrate Database Bench Sheet Report
Mussel Fk [0418763], Station #2
Sample Date: 9/28/2004 2:45:00 PM
NF = non-flow, RM = rootmat, SG = woody debris (snag)
-99 = present in sample

ORDER: TAXA	NF	RM	SG
Polypedilum illinoense grp	3	21	20
Polypedilum scalaenum grp	7		
Rheocricotopus		2	
Rheotanytarsus	35	296	23
Simulium		2	
Stempellinella	21	1	3
Stenochironomus			11
Stictochironomus	3		
Tanytarsus	151	81	57
Thienemanniella	2	4	3
Thienemannimyia grp.	7	47	20
Tribelos	8		2
EPHEMEROPTERA			
Acerpenna	11	61	40
Baetis	1	64	19
Caenis hilaris		1	1
Caenis latipennis	47	45	15
Heptageniidae		6	4
Hexagenia	3	3	
Isonychia		2	
Leptophlebiidae	14	124	10
Procloeon	3	2	
Pseudocloeon		14	
Stenacron	8	19	23
Stenonema femoratum	4		1
Tricorythodes		1	1
HEMIPTERA			
Microvelia		1	
Rheumatobates			1
ODONATA			
Argia		6	1
Calopteryx		1	
Enallagma	1	3	
Gomphidae		1	
Gomphus		-99	
Macromia			-99
TRICHOPTERA			
Cheumatopsyche	2	95	8

Aquid Invertebrate Database Bench Sheet Report
Mussel Fk [0418763], Station #2
Sample Date: 9/28/2004 2:45:00 PM
NF = non-flow, RM = rootmat, SG = woody debris (snag)
-99 = present in sample

ORDER: TAXA	NF	RM	SG
Hydroptila	1	2	
Limnephilidae		2	
Nectopsyche		1	
Phryganeidae		1	
Triaenodes		8	
TUBIFICIDA			
Limnodrilus hoffmeisteri			1
Tubificidae	4		2
VENEROIDEA			
Sphaeriidae	4	1	5

Aquid Invertebrate Database Bench Sheet Report
Mussel Fk [0418764], Station #3
Sample Date: 9/29/2004 8:45:00 AM
NF = non-flow, RM = rootmat, SG = woody debris (snag)
-99 = present in sample

ORDER: TAXA	NF	RM	SG
"HYDRACARINA"			
Acarina	2	4	6
AMPHIPODA			
Hyalella azteca	3	60	2
BRANCHIOBDELLIDA			
Branchiobdellida		4	
COLEOPTERA			
Dubiraphia	3	7	
Helichus basalis		2	
Helichus lithophilus		5	
Hydroporus		7	
Scirtes			1
DECAPODA			
Orconectes virilis	-99	1	
DIPTERA			
Ablabesmyia	23	4	2
Anopheles	1		1
Ceratopogoninae	1	4	1
Chironomus	3		
Cladotanytarsus	2		
Corynoneura	2	4	5
Cricotopus bicinctus	2	1	2
Cricotopus/Orthocladius			2
Cryptochironomus	3		
Dicrotendipes	1		5
Forcipomyiinae			1
Glyptotendipes		5	2
Kiefferulus	4		
Labrundinia	1	7	1
Nanocladius	1	9	4
Paracladopelma	1		1
Paratanytarsus	18	7	2
Phaenopsectra	4		1
Pilaria	1		
Polypedilum			1
Polypedilum convictum grp			3
Polypedilum illinoense grp	7	3	42

Aquid Invertebrate Database Bench Sheet Report
Mussel Fk [0418764], Station #3
Sample Date: 9/29/2004 8:45:00 AM
NF = non-flow, RM = rootmat, SG = woody debris (snag)
-99 = present in sample

ORDER: TAXA	NF	RM	SG
Polypedilum scalaenum grp		1	6
Procladius	2		
Rheotanytarsus	2	3	41
Stempellinella	5		2
Stenochironomus			3
Tanytarsus	94	22	39
Thienemanniella	3	2	6
Thienemannimyia grp.		12	7
Tipula	2		
Tribelos	5		
Zavrelimyia		1	
EPHEMEROPTERA			
Acentrella			2
Acerpenna	1	1	9
Baetis	2		20
Brachycercus	1		
Caenis hilaris	1		
Caenis latipennis	112	64	21
Callibaetis	1		
Hexagenia limbata	8		
Leptophlebiidae	16	362	3
Procloeon	4		
Stenacron	4	15	4
Stenonema femoratum	2	1	2
HEMIPTERA			
Corixidae		1	
Neoplea	1		
LIMNOPHILA			
Physella		1	
LUMBRICULIDA			
Lumbriculidae		1	
MEGALOPTERA			
Sialis		1	
ODONATA			
Argia		6	
Enallagma		13	
Gomphus	-99		
Progomphus obscurus	1		

Aquid Invertebrate Database Bench Sheet Report
Mussel Fk [0418764], Station #3
Sample Date: 9/29/2004 8:45:00 AM
NF = non-flow, RM = rootmat, SG = woody debris (snag)
-99 = present in sample

ORDER: TAXA	NF	RM	SG
TRICHOPTERA			
Cheumatopsyche		1	19
Limnephilidae		1	
Triaenodes		6	
TUBIFICIDA			
Enchytraeidae		1	
Tubificidae	7	2	
VENEROIDEA			
Sphaeriidae		7	

Aquid Invertebrate Database Bench Sheet Report
Mussel Fk [0418765], Station #4
Sample Date: 9/29/2004 12:45:00 PM
NF = non-flow, RM = rootmat, SG = woody debris (snag)
-99 = present in sample

ORDER: TAXA	NF	RM	SG
"HYDRACARINA"			
Acarina			1
AMPHIPODA			
Hyalella azteca	5	13	3
BRANCHIOBDELLIDA			
Branchiobdellida	1		
COLEOPTERA			
Dubiraphia	1	1	
Helichus lithophilus		6	
Hydrophilidae			1
Hydroporus	8	1	
Peltodytes	1		
Scirtes		1	1
DECAPODA			
Orconectes virilis	-99	-99	
DIPTERA			
Ablabesmyia	13	3	2
Anopheles			1
Ceratopogoninae		1	
Chironomus	1	2	
Cladotanytarsus	7		
Cricotopus bicinctus	3	2	
Cryptochironomus	1		
Dicrotendipes	8	1	3
Forcipomyiinae			1
Hemerodromia			1
Labrundinia	3	5	6
Nanocladius	1	1	1
Paracladopelma	2		
Paratanytarsus	26	1	
Phaenopsectra	5	2	
Polypedilum convictum grp		1	
Polypedilum fallax grp		1	
Polypedilum halterale grp	3		
Polypedilum illinoense grp	10	16	9
Polypedilum scalaenum grp			1
Rheotanytarsus	3	97	48

Aquid Invertebrate Database Bench Sheet Report
Mussel Fk [0418765], Station #4
Sample Date: 9/29/2004 12:45:00 PM
NF = non-flow, RM = rootmat, SG = woody debris (snag)
-99 = present in sample

ORDER: TAXA	NF	RM	SG
Simulium		2	16
Stempellinella	14	2	
Tanytarsus	117	26	29
Thienemanniella	1	1	1
Thienemannimyia grp.	1	8	15
EPHEMEROPTERA			
Acerpenna	2	19	22
Baetis		3	26
Caenis latipennis	88	54	2
Hexagenia limbata	6		
Leptophlebiidae		33	
Procloeon	2		
Pseudocloeon		3	
Stenacron	3	19	
Stenonema femoratum	1	1	1
Tricorythodes		2	1
LIMNOPHILA			
Physella		1	
MEGALOPTERA			
Sialis		-99	
ODONATA			
Argia	1	1	
Enallagma	2	7	
Gomphus		-99	
TRICHOPTERA			
Cheumatopsyche	1	42	64
Hydroptila			1
Triaenodes		3	
TUBIFICIDA			
Tubificidae		1	

Aquid Invertebrate Database Bench Sheet Report
West Locust Ck [0418761], Station #1a
Sample Date: 9/30/2004 9:45:00 AM
NF = non-flow, RM = rootmat, SG = woody debris (snag)
-99 = present in sample

ORDER: TAXA	NF	RM	SG
"HYDRACARINA"			
Acarina	1	2	
AMPHIPODA			
Hyalella azteca	1	22	
COLEOPTERA			
Dubiraphia	3	13	1
Gyrinus		-99	
Helichus lithophilus	1	11	
Hydroporus	1	2	1
DECAPODA			
Orconectes virilis		-99	
DIPTERA			
Ablabesmyia	57	8	1
Cladotanytarsus	1		2
Corynoneura		2	
Cricotopus bicinctus		1	
Cricotopus/Orthocladius			1
Cryptochironomus	15	1	5
Dicrotendipes	2		11
Endochironomus	1	1	
Glyptotendipes	6	15	1
Harnischia		1	
Kiefferulus	1		
Labrundinia	5	12	5
Nanocladius	1	5	2
Nilothauma			1
Parachironomus	3	4	5
Paracladopelma		1	
Paratanytarsus	7	9	
Phaenopsectra	1		
Polypedilum convictum grp		3	
Polypedilum illinoense grp	8	16	2
Polypedilum scalaenum grp	1	1	2
Procladius	4		
Pseudochironomus	1	1	1
Rheotanytarsus	4	41	119
Smittia			1

Aquid Invertebrate Database Bench Sheet Report
West Locust Ck [0418761], Station #1a
Sample Date: 9/30/2004 9:45:00 AM
NF = non-flow, RM = rootmat, SG = woody debris (snag)
-99 = present in sample

ORDER: TAXA	NF	RM	SG
Stempellinella	9		4
Stenochironomus			11
Tanytarsus	103	46	45
Thienemannimyia grp.	16	15	20
Tribelos	5	4	1
EPHEMEROPTERA			
Acerpenna	3	3	3
Baetis			3
Caenis hilaris	1		
Caenis latipennis	85	63	4
Leptophlebiidae	4	26	
Procloeon			3
Stenacron	5	7	4
Stenonema femoratum	2		
Stenonema terminatum	1		
LIMNOPHILA			
Ancylidae		1	
Lymnaeidae		1	
Physella	2		
MEGALOPTERA			
Sialis		-99	
ODONATA			
Argia	1	1	
Enallagma		6	
Gomphus		-99	
Nasiaeschna pentacantha		-99	
TRICHOPTERA			
Cheumatopsyche	2	4	32
Hydropsyche			1
Oecetis	1	3	1
Polycentropodidae		1	1
Triaenodes		3	
TRICLADIDA			
Planariidae		1	
TUBIFICIDA			
Tubificidae	1	4	
VENEROIDEA			
Sphaeriidae	4	-99	

Aquid Invertebrate Database Bench Sheet Report
West Locust Ck [0418762], Station #1b
Sample Date: 9/30/2004 9:45:00 AM
NF = non-flow, RM = rootmat, SG = woody debris (snag)
-99 = present in sample

ORDER: TAXA	NF	RM	SG
AMPHIPODA			
Hyalella azteca		22	
ARHYNCHOBDELLIDA			
Erpobdellidae		1	
COLEOPTERA			
Dubiraphia	4	11	
Helichus lithophilus	2	7	3
Scirtes		1	
DIPTERA			
Ablabesmyia	42	11	1
Ceratopogoninae	2	1	
Chironomus	4		
Cladotanytarsus	1		1
Corynoneura		1	
Cryptochironomus	7	1	1
Dicrotendipes			7
Endochironomus	1	1	1
Glyptotendipes		4	5
Labrundinia	6	5	6
Lipiniella	20		
Nanocladius		2	
Parachironomus	1	4	5
Paratanytarsus	3	7	
Phaenopsectra		1	
Polypedilum	1		
Polypedilum convictum grp		1	
Polypedilum halterale grp	1		
Polypedilum illinoense grp	5	6	4
Pseudochironomus	2		6
Rheotanytarsus		234	125
Simulium			1
Stempellinella	10	1	1
Stenochironomus			20
Tanytarsus	93	30	18
Thienemanniella		1	
Thienemannimyia grp.	3	37	20

Aquid Invertebrate Database Bench Sheet Report
West Locust Ck [0418762], Station #1b
Sample Date: 9/30/2004 9:45:00 AM
NF = non-flow, RM = rootmat, SG = woody debris (snag)
-99 = present in sample

ORDER: TAXA	NF	RM	SG
Tribelos	4	2	
EPHEMEROPTERA			
Acerpenna	1	4	8
Baetis		1	2
Caenis latipennis	82	56	1
Leptophlebiidae	2	15	2
Stenacron	3	3	3
LIMNOPHILA			
Physella	4	1	1
LUMBRICULIDA			
Lumbriculidae		1	
ODONATA			
Argia		1	
Boyeria		-99	
Enallagma		3	
Gomphus		-99	
RHYNCHOBDELLIDA			
Glossiphoniidae		-99	
TRICHOPTERA			
Cheumatopsyche	1	36	19
Hydroptila			1
Limnephilidae		1	2
Nectopsyche	3	2	1
TRICLADIDA			
Planariidae		1	
TUBIFICIDA			
Branchiura sowerbyi	-99	3	
Enchytraeidae	1		
Tubificidae	2	2	1
VENEROIDEA			
Sphaeriidae	14	6	-99

APPENDIX C
Spring 2005
Macroinvertebrate Bench Sheets

Aquid Invertebrate Database Bench Sheet Report
Mussel Fk [0503048], Station #1
Sample Date: 3/24/2005 11:00:00 AM
NF = non-flow, RM = rootmat, SG = woody debris (snag)
-99 = present in sample

ORDER: TAXA	NF	RM	SG
"HYDRACARINA"			
Acarina	1		3
AMPHIPODA			
Hyalella azteca		1	
COLEOPTERA			
Dineutus	-99	3	
Dubiraphia	5	1	
Peltodytes		1	
DIPTERA			
Ablabesmyia	4	1	
Ceratopogoninae	6		
Chaoborus	1		
Cladotanytarsus	7		
Corynoneura	2	6	1
Cricotopus bicinctus	1	3	1
Cricotopus/Orthocladius	8	13	15
Cryptochironomus	2		
Dicrotendipes	2		4
Diptera		1	
Hemerodromia		1	5
Hydrobaenus	8		
Labrundinia	1		
Nanocladius	1	1	1
Nilothauma			1
Ormosia	2		
Paracladopelma	11		
Parakiefferiella			1
Paralauterborniella	1		
Paratanytarsus	2	5	5
Phaenopsectra	1		
Polypedilum convictum grp	2	3	
Polypedilum halterale grp	5		1
Polypedilum illinoense grp		11	2
Polypedilum scalaenum grp	8		
Procladius	2		
Pseudochironomus			4
Pseudosmittia		1	

Aquid Invertebrate Database Bench Sheet Report
Mussel Fk [0503048], Station #1
Sample Date: 3/24/2005 11:00:00 AM
NF = non-flow, RM = rootmat, SG = woody debris (snag)
-99 = present in sample

ORDER: TAXA	NF	RM	SG
Rhamphomyia	2		
Rheotanytarsus	1	14	129
Saetheria		1	
Simulium	13	269	28
Stenochironomus	1		4
Stictochironomus	1		
Tanytarsus	83	16	36
Thienemanniella	5	16	
Thienemannimyia grp.	1	2	6
Tribelos	2		
Zavrelimyia	3	2	1
EPHEMEROPTERA			
Acerpenna	5	36	8
Caenis latipennis	28	3	1
Heptagenia	1	1	1
Hexagenia limbata	1		
Leptophlebia	2	3	
Procloeon		1	
Stenacron	6	2	7
Stenonema femoratum	4	1	
Stenonema terminatum			2
HEMIPTERA			
Trichocorixa	1		
MEGALOPTERA			
Sialis	1		
ODONATA			
Argia	1		
Enallagma	1		
PLECOPTERA			
Perlesta		1	2
RHYNCHOBDELLIDA			
Piscicolidae	1		
TRICHOPTERA			
Cheumatopsyche	3	1	4
Cyrnellus fraternus			4
Hydroptila			2
TUBIFICIDA			
Enchytraeidae	3		

Aquid Invertebrate Database Bench Sheet Report
Mussel Fk [0503048], Station #1
Sample Date: 3/24/2005 11:00:00 AM
NF = non-flow, RM = rootmat, SG = woody debris (snag)
-99 = present in sample

ORDER: TAXA	NF	RM	SG
Limnodrilus hoffmeisteri	2		
Tubificidae	3		

Aquid Invertebrate Database Bench Sheet Report
Mussel Fk [0503047], Station #2
Sample Date: 3/23/2005 2:00:00 PM
NF = non-flow, RM = rootmat, SG = woody debris (snag)
-99 = present in sample

ORDER: TAXA	NF	RM	SG
AMPHIPODA			
Hyalella azteca	1	1	
COLEOPTERA			
Dineutus	-99	-99	
Dubiraphia	3		
Helichus lithophilus		3	
Hydroporus	1		
DIPTERA			
Ablabesmyia	10		
Axarus	1		
Ceratopogoninae	2	1	
Cladotanytarsus	3		
Corynoneura	7	3	
Cricotopus bicinctus	3	2	7
Cricotopus/Orthocladius	12	18	47
Cryptochironomus	1		
Dicrotendipes	4	1	1
Diptera		1	
Glyptotendipes	1		
Hemerodromia			1
Hydrobaenus	25	4	12
Larsia	3		
Nanocladius	2	2	
Paracladopelma	3		
Paraphaenocladius	2	1	
Paratanytarsus	25	2	9
Pericoma		1	
Phaenopsectra	2		2
Polypedilum convictum grp	2	1	5
Polypedilum halterale grp	2	1	
Polypedilum illinoense grp		13	6
Polypedilum scalaenum grp	5		1
Rheotanytarsus	7	3	30
Simulium	18	164	125
Stictochironomus	4		
Tanytarsus	37	7	11
Thienemanniella	3	7	3

Aquid Invertebrate Database Bench Sheet Report
Mussel Fk [0503047], Station #2
Sample Date: 3/23/2005 2:00:00 PM
NF = non-flow, RM = rootmat, SG = woody debris (snag)
-99 = present in sample

ORDER: TAXA	NF	RM	SG
Thienemannimyia grp.	13	7	7
Zavrelimyia	4	1	
EPHEMEROPTERA			
Acerpenna	17	39	8
Caenis latipennis	27	6	3
Heptagenia	2		
Hexagenia limbata	1		
Leptophlebia	3	8	1
Stenacron	6	1	
Stenonema femoratum	1		
HEMIPTERA			
Trichocorixa		1	
ODONATA			
Gomphus	1		
Progomphus obscurus	2		
PLECOPTERA			
Perlidae	1	4	2
RHYNCHOBDELLIDA			
Piscicolidae	1		
TRICHOPTERA			
Cheumatopsyche	4	6	7
Hydroptila			1
TUBIFICIDA			
Enchytraeidae	5	5	
Ilyodrilus templetoni	1		
Limnodrilus cervix	1		
Limnodrilus hoffmeisteri	7		
Tubificidae	30		
VENEROIDEA			
Sphaeriidae	1		

Aquid Invertebrate Database Bench Sheet Report
Mussel Fk [0503046], Station #3
Sample Date: 3/23/2005 10:00:00 AM
NF = non-flow, RM = rootmat, SG = woody debris (snag)
-99 = present in sample

ORDER: TAXA	NF	RM	SG
"HYDRACARINA"			
Acarina	2	1	1
AMPHIPODA			
Crangonyx		-99	
Hyalella azteca	2	4	1
COLEOPTERA			
Agabus		-99	
Berosus	1		
Dubiraphia	4	2	
Helichus lithophilus		1	
Hydroporus	2		
DIPTERA			
Ablabesmyia	8	2	3
Ceratopogoninae			1
Chaoborus	1		
Cladotanytarsus	1		
Corynoneura	7	10	4
Cricotopus bicinctus	4	3	9
Cricotopus/Orthocladius	16	32	71
Cryptochironomus	3	1	
Dicrotendipes			2
Glyptotendipes	2		
Hydrobaenus	18	6	11
Labrundinia		2	
Paracladopelma	2		
Paralauterborniella	1		
Parametriocnemus		1	1
Paratanytarsus	25	36	26
Paratendipes	1		
Phaenopsectra	10	2	2
Polypedilum convictum grp	1	1	1
Polypedilum fallax grp	1		
Polypedilum halterale grp	17		
Polypedilum illinoense grp	11	12	11
Polypedilum scalaenum grp	4		
Rheotanytarsus	3	9	4
Simulium	4	40	44

Aquid Invertebrate Database Bench Sheet Report
Mussel Fk [0503046], Station #3
Sample Date: 3/23/2005 10:00:00 AM
NF = non-flow, RM = rootmat, SG = woody debris (snag)
-99 = present in sample

ORDER: TAXA	NF	RM	SG
Stenochironomus	1		2
Stictochironomus	2		
Tanytarsus	34	18	25
Thienemanniella	2	5	8
Thienemannimyia grp.	15	29	26
Tribelos	1		
Zavrelimyia	10		
EPHEMEROPTERA			
Acerpenna	6	22	15
Caenis latipennis	27	48	10
Heptagenia		4	2
Heptageniidae	1	2	
Hexagenia limbata	1		
Leptophlebia	5	2	1
Stenacron		4	
Stenonema femoratum	1	2	
Stenonema terminatum		1	1
HEMIPTERA			
Hesperocorixa	1		
Ranatra fusca		-99	
Trichocorixa		1	
LIMNOPHILA			
Fossaria	1		
LUMBRICINA			
Lumbricina	8		
ODONATA			
Enallagma		2	
Gomphus	1		
Progomphus obscurus	3		
PLECOPTERA			
Perlesta		1	3
TRICHOPTERA			
Cernotina		1	
Cheumatopsyche	4	10	6
TUBIFICIDA			
Enchytraeidae	1		
Limnodrilus hoffmeisteri	1		

Aquid Invertebrate Database Bench Sheet Report
Mussel Fk [0503045], Station #4
Sample Date: 3/22/2005 2:00:00 PM
NF = non-flow, RM = rootmat, SG = woody debris (snag)
-99 = present in sample

ORDER: TAXA	NF	RM	SG
"HYDRACARINA"			
Acarina	2	1	
AMPHIPODA			
Hyalella azteca		10	
COLEOPTERA			
Dubiraphia		1	
Hydroporus		1	
Peltodytes		3	
DIPTERA			
Ablabesmyia	30		1
Ceratopogoninae	3		
Cladotanytarsus	14	2	1
Corynoneura	6	6	1
Cricotopus bicinctus	1	14	12
Cricotopus/Orthocladius	2	37	97
Cryptochironomus	3	1	
Dicrotendipes	1		32
Eukiefferiella			5
Glyptotendipes		1	
Hemerodromia			2
Hydrobaenus	6	11	13
Labrundinia	1	1	
Nanocladius		1	
Nilothauma			2
Oliveridia			4
Ormosia			1
Paracladopelma	1		1
Parakiefferiella			2
Paraphaenocladius			1
Paratanytarsus	31	37	23
Paratendipes	2		
Pericoma	1		
Phaenopsectra	1		3
Polypedilum convictum grp		1	1
Polypedilum fallax grp			1
Polypedilum halterale grp	4		
Polypedilum illinoense grp	1	10	2

Aquid Invertebrate Database Bench Sheet Report
Mussel Fk [0503045], Station #4
Sample Date: 3/22/2005 2:00:00 PM
NF = non-flow, RM = rootmat, SG = woody debris (snag)
-99 = present in sample

ORDER: TAXA	NF	RM	SG
Polypedilum scalaenum grp	8		
Pseudochironomus			3
Rheotanytarsus	1	2	5
Simulium	1	7	13
Stenochironomus			5
Stictochironomus	6		
Tanytarsus	46	32	48
Thienemanniella	1	7	10
Thienemannimyia grp.	7	10	14
Tipula	1	-99	
Zavrelimyia	7		
EPHEMEROPTERA			
Acerpenna	4	20	8
Baetidae		1	
Caenis latipennis	22	17	7
Leptophlebia		-99	
Stenacron	3		1
Stenonema femoratum	1		1
ODONATA			
Enallagma	1	3	
Gomphus	-99		
PLECOPTERA			
Amphinemura			1
Perlidae		1	2
RHYNCHOBDELLIDA			
Piscicolidae	1		
TRICHOPTERA			
Cheumatopsyche	1		4
VENEROIDEA			
Sphaeriidae	3	1	

Aquid Invertebrate Database Bench Sheet Report
West Locust Ck [0503065], Station #1
Sample Date: 4/5/2005 4:15:00 PM
NF = non-flow, RM = rootmat, SG = woody debris (snag)
-99 = present in sample

ORDER: TAXA	NF	RM	SG
"HYDRACARINA"			
Acarina	1		1
AMPHIPODA			
Hyalella azteca		14	
COLEOPTERA			
Dubiraphia		7	1
Helichus lithophilus			1
DECAPODA			
Orconectes virilis		-99	
DIPTERA			
Ablabesmyia	6	4	
Ceratopogoninae	1	1	
Chironomus	1		
Cladotanytarsus	12	1	
Corynoneura		1	
Cricotopus bicinctus	2	4	1
Cricotopus/Orthocladius	25	13	43
Cryptochironomus	13	3	1
Cryptotendipes	1		
Glyptotendipes	1		1
Hydrobaenus	2		
Labrundinia		1	
Lipiniella	1		
Nanocladius	1	1	2
Paracladopelma	2		
Paralauterborniella	3	1	
Paraphaenocladius		1	
Paratanytarsus	30	34	4
Paratendipes	1		
Phaenopsectra	3	3	2
Polypedilum convictum grp	1		32
Polypedilum fallax grp			4
Polypedilum halterale grp	9		
Polypedilum illinoense grp	10	15	13
Polypedilum scalaenum grp	10		
Procladius	1		
Pseudochironomus	1		

Aquid Invertebrate Database Bench Sheet Report
West Locust Ck [0503065], Station #1
Sample Date: 4/5/2005 4:15:00 PM
NF = non-flow, RM = rootmat, SG = woody debris (snag)
-99 = present in sample

ORDER: TAXA	NF	RM	SG
Rheotanytarsus	15	62	56
Saetheria	1		
Simulium	2	3	23
Stenochironomus	1		
Tanytarsus	112	95	47
Thienemannimyia grp.	8	19	9
Tribelos	1		
Zavrelimyia		1	
EPHEMEROPTERA			
Acerpenna	2	14	10
Caenis latipennis	53	43	6
Heptagenia			1
Hexagenia limbata	5		
Leptophlebia	1	4	
Stenacron	2	4	2
Stenonema femoratum	1		-99
Stenonema terminatum		-99	
LIMNOPHILA			
Physella		-99	
ODONATA			
Argia		1	
Enallagma		2	
Macromia		1	
Nasiaeschna pentacantha		1	
Progomphus obscurus	1		
PLECOPTERA			
Perlidae			1
TRICHOPTERA			
Cheumatopsyche	6	4	4
TUBIFICIDA			
Branchiura sowerbyi	1		
Limnodrilus hoffmeisteri	2		
Tubificidae	2		
VENEROIDEA			
Sphaeriidae	1	-99	

Appendix D
Fall 2004
Channel Width and Depth Data

Lower Mussel Fork 1

Transect	Channel Width (ft)	Wetted Width (ft)	Depth of stream at % of wetted width (ft):		
			25%	50%	75%
1	37	35	0.6	0.35	0.85
2	28	28	1.75	1.25	1.9
3	55	43	2.5	2.25	2.4
4	40	40	2.35	2.45	2.05
5	28	22	1.25	1.5	1.3
6	55	31	1.75	1.85	1.3
7	34	34	2.7	2.3	1.7
8	63	35	1.2	1.3	0.9
9	47	29	0.55	0.8	0.9
10	24	22.5	0.6	1	0.8
Average	41.1	31.95	1.525	1.505	1.41

Lower Mussel Fork 2

Transect	Channel Width (ft)	Wetted Width (ft)	Depth of stream at % of wetted width (ft):		
			25%	50%	75%
1	77	10	0.2	0.35	0.35
2	61	16	0.425	0.5	0.4
3	33	33	1.15	2.7	3.35
4	53	53	1.85	1.8	2
5	55	32	0.3	0.9	1.3
6	41	20	0.2	0.55	0.8
7	40	14	0.45	0.8	1.05
8	67	21	0.25	0.2	0.25
9	54	16	0.5	0.45	0.2
10	31	28	3.1	2.9	1.75
Average	51.2	24.3	0.8425	1.115	1.145

Lower Mussel Fork 3

Transect	Channel Width (ft)	Wetted Width (ft)	Depth of stream at % of wetted width (ft):		
			25%	50%	75%
1	50	11	0.5	0.4	0.45
2	53	5	0.4	0.6	0.6
3	55	6	0.3	0.35	0.25
4	45	20	0.3	0.3	0.3
5	46	0.15	0.2	0.5	0
6	46	6	0.35	0.3	0.5
7	46	12	0.2	0.4	0.25
8	42	10	0.2	0.2	0.2
9	42	13	0.33	0.25	0.2
10	43	15	0.1	0.2	0.3
Average	46.8	9.815	0.288	0.35	0.305

Lower Mussel Fork 4

Transect	Channel Width (ft)	Wetted Width (ft)	Depth of stream at % of wetted width (ft):		
			25%	50%	75%
1	26	13	0.3	0.42	0.35
2	10	10	0.6	0.8	0.65
3	17	12.5	0.3	0.3	0.2
4	51	40	0.25	0.45	1
5	55	13	0.25	0.2	0.2
6	46	12	0.1	0.15	0.4
7	52	22	0.2	0.1	0.1
8	40	15	0.1	0.3	0.35
9	28	16	0.2	0.15	0.15
10	37	19	0.15	0.2	0.25
Average	36.2	17.25	0.245	0.307	0.365

West Locust Creek 1

Transect	Channel Width (ft)	Wetted Width (ft)	Depth of stream at % of wetted width (ft):		
			25%	50%	75%
1	51	51	1.15	1.5	3.65
2	45	45	1.6	1.1	0.4
3	32	12	0.5	0.6	0.4
4	37	10	0.15	0.2	0.15
5	17	17	0.2	0.4	0.35
6	50	10	0.2	0.4	0.65
7	36	12	2.9	2.9	0.9
8	45	30	1.6	1.95	1.3
9	44	19	3.4	3	2
10	51	27	3.7	3.1	1.9
Average	40.8	23.3	1.54	1.515	1.17